



Bread with *Pennisetum glaucum* (L. R. Br.) seed flour: food product development

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Gabriela de Souza Silva

Patrícia Cintra

Andreia de Oliveira Massulo

Lucas de Melo da Silva

ABSTRACT

This is an experimental, descriptive, and cross observational research that reported the formulation of bread with flour of *Pennisetum glaucum* (L. R. BR.) in

concentrations (10, 20 and 50%) in replacement of white wheat flour. In this study, the technical sheet of preparation and nutritional information of the product was made. The formulation with 20% millet stood out in the sensorial analysis with a harmonic and attractive flavor, with a 95% yield, a cost of R\$ 12,41 and a total weight of 826g. The development of this product verified the possibility of using millet flour for the production of food products with nutritional characteristics and low cost for preparation. The insertion of millet in human nutrition is of great interest because besides being a whole grain, it is gluten-free and rich in nutrients.

1 INTRODUCTION

Popularly known as millet, *Pennisetum glaucum* originated in Africa and India. It belongs to the family Poaceae (gramineae) of the genus *Pennisetum*⁷. The species that has expanded the most in Brazil since 1929 is *Pennisetum glaucum* (L.R.Br), has undergone adaptations to progress in the South, Southeast, and Midwest regions of the country^{8, 20}.

It comes from a semi-arid tropical climate and has a summer cycle of 75 to 120 days per year, depending on environmental conditions. It generally grows quickly, with an average height of 1.5 to 3 meters, and is widely used for ground cover in planting and grazing areas. The plant grows in compact cylindrical panicles 2 to 3 cm wide and 15 to 60 cm long, each panicle is capable of producing 500 to 2,000 seeds, besides that the grains at maturity are small, gray, white, yellow or mixed^{32, 14}.

The millet *Pennisetum glaucum* (L.R.BR) is a tropical annual pasture, adapts to arid and semiarid tropics, water shortage, heat and soil with low natural fertility²¹. With its great ease of adaptation to the Brazilian Cerrado, millet stands out in recent years with the arrival of hybrids with high prolific potential due to genetic improvement. Thus, making this plant not only a simple no-till plant, but it is considered an important crop with economic value in the production of grains and pastures. Thus becoming widely distributed in the region¹³.

For uniform and more profitable production, millet needs more calories than crops such as corn and sorghum. There are thermal and water requirements for the millet plant, average night time temperatures range from 15 - 28°C with an average of 30mm of water used for germination. These characteristics

highlight the advantages of millet when compared to other crops used as ground cover in the Brazilian cerrado¹⁵.

According to the current resolution RDC No. 712/2022 from Anvisa, millet grains were classified and authorized as a whole grain cereal⁵, gluten-free, non-transgenic and its cost is lower when compared to corn and rice²³. Standing out as the sixth cereal produced worldwide, millet is being used in human food in countries in Africa, Asia, and North America, and is the source of protein for the population of the semi-arid regions of the African continent. This makes it the cereal that generates food security for this population. The food products that are derived from millet include breads, puddings, pancakes, couscous, non-alcoholic fermented beverages, porridges, beers, and cooked whole grains are also consumed. Some nutrients present in millet as its high content of protein and fiber, gluten-free makes it a cereal with great interests to be inserted in the Brazilian population's diet^{25, 24}.

The cultivation of millet in Brazil is gaining significant increase because it is an economical option, its price is lower when compared to corn and they have similarities in nutritional chemical composition, therefore, there is a need to conduct studies for the development of this cereal in the diet of the Brazilian population^{17, 24}.

The chemical characteristics of millet have nutritional advantages and may vary due to genotype, climatic conditions, soil nutrient content and type of processing²³. 11.8% protein type (albumin and globulin) is found in millet grains¹⁸. The indispensable amino acids are also present in its composition being: leucine (10,7%), isoleucine (4,4%), lysine (3,1%) and methionine in smaller quantity (1,1%)²³. According to Souza; Silva; Silva²⁹, the following amino acid contents were found: 0.88% arginine, 0.34% cystine, 0.39% histidine, 0.64% isoleucine, 1.06% leucine, 0.46 lysine, 0.30% methionine, 0.45% phenylalanine, 0.12% tryptophan and 0.70% vanilla.

According to Martins²³, it can be found in millet grains 72.2% of carbohydrates that are the main constituents of cereals: starch, followed by dietary fiber 7.8% and 1.8% of minerals. The consumption of fiber should be stimulated, because it provides health benefits, as well as reduces symptoms of depression, incidence of inflammatory bowel diseases, and heart problems²².

Lipids are present in large quantities in millet 6.4%²³. The fatty acids present in its composition are: linoleic acid 39-45%, oleic acid 21-27% and palmitic acid 20-21%^{32, 3}, Oliveira and Slama^{24, 27}, found 25% oleic acid and 25 to 46% linoleic acid.

While, the bioactive compounds present in millet enrich the grain with sources of phenolic compounds and antioxidants^{10, 31}, it is believed that this grain is a nutritious cereal that can provide health benefits to the individual.

Thus, the objective of the work was to develop a bakery product with nutritional properties such as fiber, minerals and proteins in order to fortify the standard recipe, with formulations of (10, 20 and 50%) using *Pennisetum glaucum* (L. R. BR.) seed flour as a substitute for wheat flour.

2 METHODOLOGY

This is an experimental, descriptive, quantitative, and cross-sectional observational research that reported the formulation and the preparation technical sheet adapted from Domene¹⁴. For the theoretical basis, a literature review was performed by consulting Pubmed and Scielo research platforms to search for scientific articles, theses, and course completion papers in Portuguese and English.

The experiment of this study took place in the experimental kitchen of the Unigran Capital University Center.

The millet grains were acquired from a rural producer, who provided the grains planted and harvested on his farm located in Rio Verde de Mato Grosso - MS. The study lasted six months, the tests performed for the elaboration of bread with millet flour were divided into three stages, considering three different concentrations: 10, 20 and 50% of *Pennisetum glaucum* (L. R. BR.) flour replacing wheat flour. The formulation of the breads was adapted from the 10-50D method, described by AACC². To obtain the amount of 450g of millet flour used for the production of the formulations, 1kg of *Pennisetum glaucum* (L. R. BR.) seeds were ground, according to (FIGURE 1). According to Silva²⁶, the flour production process was adapted, according to (FIGURE 1). They were stored in a cool place and in sterile glass container. It can be seen in (TABLE 1) the ingredients used for bread making. In the manufacturing process individual protection equipment and good manufacturing practices were used so that there would be no contamination of the food, and consequently no risk to the consumer's health. The production of the bread took two and a half hours, considering pre-preparation and preparation to complete the entire manufacturing process, as described in (TABLE 1).

The cost of the preparation was calculated according to the values observed in the local market of Campo Grande - MS, in the period July/2022, the quantities of the ingredients were determined according to the portions used for the formulation and the value of the fraction was calculated proportionally to the value of the whole product.

3 RESULTS AND DISCUSSIONS

To reproduce the homemade bread recipe with the millet flour formulation (10, 20, and 50%), the ingredients from the standard formulation were used.

Determining the cost of formulations

To determine the cost of the preparation and the nutritional information table, the bread made with 20% millet flour was chosen. This choice was made by sensory analysis of the authors, using the criteria vision, smell, taste, touch and hearing of organoleptic conditions¹.

After studying the cost of the preparation, we suggest that the product has low cost (R\$12.41), making it an interesting food to be inserted in the Brazilian diet. The (TABLE 2) presented the quantities of the ingredients and the cost.

Preparation of the technical data sheet

With the production of the bread with the 20% millet formulation, a preparation data sheet was prepared, which is very efficient for recipe standardization and product quality control. This resource guarantees that the preparation is provided with the same quality every time it is prepared. Figure 2 shows the data from the 20% millet formulation, where we obtained a total weight of 826g, a 95% yield, 16 servings of 50g and 298 kcal/g per serving.

Nutritional value of bread with millet flour

Formulations of 10%, 20%, and 50% millet flour were used in each concentration and the characteristics found were different, from dough preparation to the final product ready for consumption.

The characteristics of the preparations vary according to the concentration used of millet flour for the production, in the 50% concentration it was observed a dark-colored dough, a stiffer texture and a strong apparent taste of millet because it presents a larger amount of this flour, when compared to the other concentrations. The preparation with the 10% concentration of flour was visualized a light coloration and soft texture, due to the smaller amount of millet with its softer taste.

It is suggested that the 20% millet flour concentration was the one that stood out in the sensory analysis, yield, cost, and in its chemical composition. The preparation presented a soft texture and light coloration. The yield of the preparation was 95%, containing 16 servings of 50g of 298 kcal/g per serving. In (TABLE 1) one can see the nutritional information of the bread per 100g and per 50g. In (TABLE 1) are expressed the information about the list of ingredients, presence of allergens and other guidelines, to be described in the labeling of the product.

Some differences in texture and coloration can be observed according to the variety of millet flour concentration for bread preparation. The higher the concentration the stiffer and darker the dough, with the decrease in the amount of millet flour the bread presents a dough with a soft texture and light color. The concentration that obtained the highest yield was the 20% with 95%, followed by the 50% concentration with 90% yield, and lastly the 10% concentration with 88% yield.

The millet bread recipe is easy to prepare and suggested low cost, with a total of R\$12.41 being spent to make these recipes regardless of the preparation.

Millet flour can be used in combination with different types of flours such as oat flour, rice flour, almond flour, among others, making it possible to make gluten-free recipes to be offered to celiac people.

According to Araújo⁴, the supply of food suitable for celiacs is restricted making the diet dull, and the food products found in the markets are usually of high cost.

In the literature it is observed that the bread with 20% millet flour obtained a chemical composition with 9% carbohydrate, when comparing this data with similar works. In the study of Hajj¹⁹ the preparation of bread with bocaiúva flour obtained 65.19% carbohydrate. While, Freires and Viera¹⁶ used flour from munguba nut to produce bread that showed average carbohydrate values ranging between (38.80 and 49.80%). Souza²¹ prepared tube bread with yam and flour mix with 6% carbohydrate.

Regarding the protein content, the bread presented 7.5% protein. Hajj¹⁹ found 2.40% protein, the study of Freires and Viera¹⁶ showed protein values ranging from (6.26 to 12.34%), while Souza²¹ found 3% protein in their production.

As for lipid, in the formulation with 20% millet 10% lipid was found. According to Hajj¹⁹ the preparation obtained 8.68% lipid. Freires and Viera¹⁶ found values varying between (12.40 and 19.91%) of lipids, while Souza¹¹ found 9% of lipids.

The dietary fibers that make up the millet bread correspond to 3%. In Hajj¹⁹ study, the value of dietary fiber is included in the carbohydrate value that has 65.19%, while in Souza²¹ study, 11% of dietary fiber was found.

As for the cost according to Cintra¹¹, to determine the cost of this production the direct cost was used, based on the volume needed for preparation.

The bread with 20% millet showed a total cost of R\$ 12.41 with total weight of 826g. Hajj¹⁹ in his study obtained in the bread with 20% bocaiúva flour a total cost of R\$ 23.59 with total weight of 1,600g. According to Souza²¹ his study showed a total cost of R\$ 5.40 in 10 units of bisnaguinha, containing 300g in total weight.

The manufacture of food products with the flour of *Pennisetum glaucum* (L. R. BR.) can be considered advantageous due to this cereal being nutritious and low cost. It is suggested that future studies be developed with new tests analyzed in laboratories, sensory analysis performed with tasters for better evaluation and acceptability of the product.

4 CONCLUSION

Millet grains present great potential as food, besides being considered low cost for production. The evaluation of the potential use and benefit of millet as food should be done, because it is a viable alternative for consumers who seek low-cost food and that are nutritious. Besides being a whole grain that does not have gluten, it can be inserted in the diet of celiac people.

This study verified the possibility of mixing the millet flour with wheat flour to produce a food product popularly known as homemade bread with harmonic flavor. With the development of this study it

is possible to observe the importance of having a deep study about millet and its benefits in order to promote its insertion in human nutrition.

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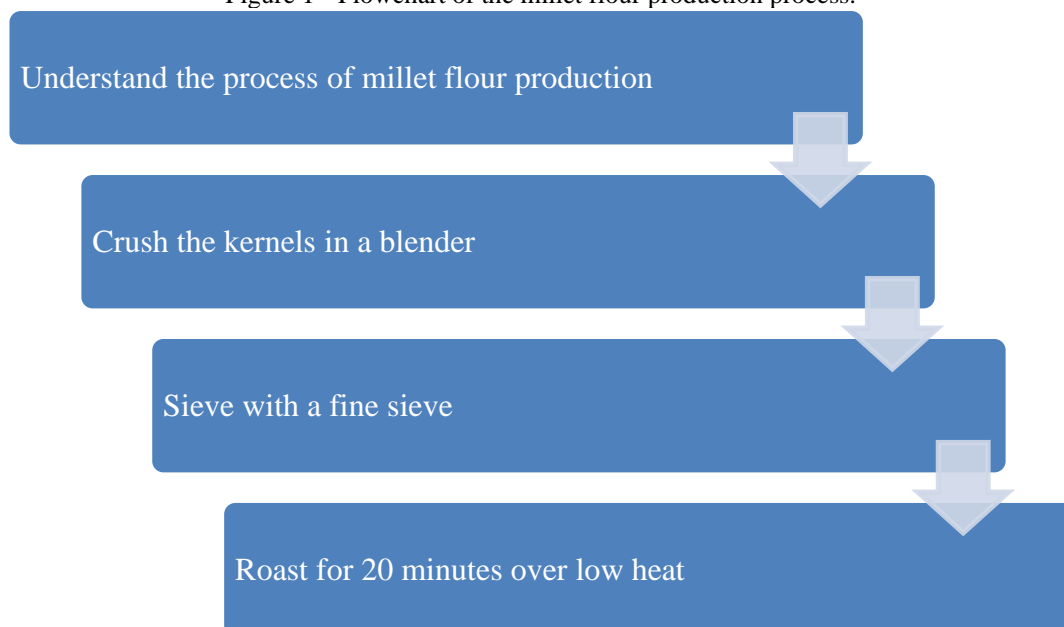
Table 1 - Ingredients used to make bread with millet flour.

Ingredients	Standard formulation	10% millet formulation	20% Millet formulation	50% Millet Formulation
Wheat flour	500g	450g	400g	250g
Millet meal	-	50g	100g	250g
Egg	64g	64g	64g	64g
Sugar	70g	70g	70g	70g
Oil	85ml	85ml	85ml	85ml
Milk	100ml	100 ml	100 ml	150 ml
Water	50ml	50 ml	50 ml	50 ml
Biological yeast	10g	10g	10g	10g

Directions: **1** - In a bowl add the egg, sugar, oil, milk, water and yeast, stir until all ingredients are mixed. **2** - Add the wheat flour and mix, when the dough is homogeneous add the millet flour, knead the dough. **3**- Let it rest for 50 minutes until it doubles in size. **4**- After the dough has rested, roll it up and put it in the baking pan. Rest it for 20 minutes more. **5- Bake** in a pre heated oven for 1 hour at 210°C.

Source: Authors (2022).

Figure 1 - Flowchart of the millet flour production process.



Source: Adapted from SILVA²⁷.

Table 2 - Cost of bread preparation with 20% millet flour formulation.

Preparation Name: Bread with 20% <i>Pennisetum glaucum</i> (L. R. BR.) flour formulation Total yield: 826g		Unit cost: R\$ 12.41 Total cost: R\$49.96		
Serving Yield: 50g No. of servings: 16				
Ingredients	Quant (g/mL)	Unit Cost	Total (R\$)	IPC/FC
Wheat flour	400g	2,00	4,50	1
Millet meal	100g	2,80	2,80	1
Chicken egg	64g	0,75	18,99	1,16
Crystal sugar	70g	0,65	5,29	1
Soybean oil	85g	0,95	9,90	1
Cow's milk	100ml	1,50	4,99	1
Warm water	50ml	-	-	1
Biological yeast	10g	3,49	3,49	1
Directions: 1 - In a bowl add the egg, sugar, oil, milk, water and yeast, stir until all ingredients are mixed. 2 - Add the wheat flour and mix, when the dough is homogeneous add the millet flour, knead the dough. 3 - Let it rest for 50 minutes until it doubles in size. 4 - After the dough has rested, roll it up and put it in the baking pan. Rest it for 20 minutes more. 5- Bake in a pre heated oven for 1 hour at 210°C.				

Source: Authors (2022)

Figure 2 - Data sheet for preparation of bread with 20% millet flour formulation.

Nome da preparação: Pão com farinha de milho 20%															
Indicação de uso: Acompanhamento												Data: 25/07/2022			
Ingredientes		Peso		IPC	%DP	Custo		Cálculo dietético							
Alimento	Medida caseira	Bruto	Líquido			Mercado R\$:	Fração R\$:	Carboidrato	Proteína	Lipídio	Fibra	Sódio	Açúcar de adição	Gordura trans	Gordura saturada
Farinha de trigo	2 xíc.	400g	400g	1		4,50	2,00	291,6	42,8	5,44	10,32	3	-	0,4	1,24
Farinha de milho	1 ½ xíc.	100g	100g	1		2,80	2,80	72,2	11,8	6,4	7,8	-	-	-	-
Ovo de galinha	1 unid.	64g	55g	1,16		18,99	0,75	1,17	6,21	4,97	-	88	-	0,01	1,45
Açúcar cristal	4 col. sopa	70g	70g	1		5,29	0,65	69,72	0,22	-	-	-	70	-	-
Óleo	½ xíc	85g	85g	1		9,90	0,95	-	-	85	-	-	-	0,425	12,92
Leite de vaca	1 xíc	100ml	100ml	1		4,99	1,50	7,16	2,35	3,04	-	63,8	-	0,02	1,40
Água morna	¼ xíc	50ml	50ml	1		-	-	-	-	-	-	-	-	-	-
Fermento biológico		10g	10g	1		3,49	3,49	4,39	0,05	0,01	-	1005	-	-	-
						49,96	12,41								
Peso total	826kg	879	870					446,24	63,43	104,86	18,12	1.159,8	70	0,855	17,01
Peso total por porção	50g							1.784,96	253,72	943,74					
Modo de preparo															
Em uma bacia adicione o ovo, açúcar, óleo, leite, água e o fermento, mexer até misturar tudo. Adicione a farinha de trigo e misture, quando fica homogênea adicione a farinha de milho, sovar a massa e deixe descansar por 50 minutos até que dobre de tamanho. Após o descanso, enrolar a massa e colocar na forma, deixe descansar por mais 20 minutos. Levar ao forno pré aquecido por 1 hora a 210°C.															
Rendimento: 95%										Total Kcal: 2.982,42 kcal/g		Kcal por porção: 298 kcal/g			
Peso cozido: 826								IC: 0,94		Densidade energética: 3,61 kcal/g					
Número de porções: 16								Peso da porção: 50g							
Análise sensorial: Sabores harmônicos, equilíbrio entre eles, agridoce, apresentação atraente.															

Source: TBCA³⁰.

Table 1 - Table of nutritional information as recommended by the Normative Instruction - IN No. 75, of October 8, 2020 and RDC No. 429, of October 8, 2020.

NUTRITION INFORMATION			
Servings per package: 16 servings			
Serving size: 50 g (1 medium slice)			
	100g	50g	% VD
Energetic value (kcal)	361g	180g	7,5%
Total carbohydrates (g)	54g	27g	9%
Added sugar (g)	8,5g	4,2g	8%
Lactose (g)	6,3	3,1g	-
Proteins (g)	7,7g	3,9g	7,5%
Total Fats (g)	12g	6,3g	10%
Saturated fats (g)	2g	1g	5%
Trans fat (g)	0,10g	0,05g	2,5%
Dietary fiber (g)	2,2g	1,1g	4%
Sodium (mg)	140mg	70.2mg	3,5%
List of ingredients: wheat flour, millet flour, cow's milk, sugar, soybean oil, water, and biological yeast.			
ALLERGIC: CONTAINS GLUTEN. CONTAINS LACTOSE.			
Storage recommendation: keep in a dry and well-ventilated place. Consume within 7 days after preparation.			
Suggested consumption: 50g (1 slice)			

Source: Authors (2022)